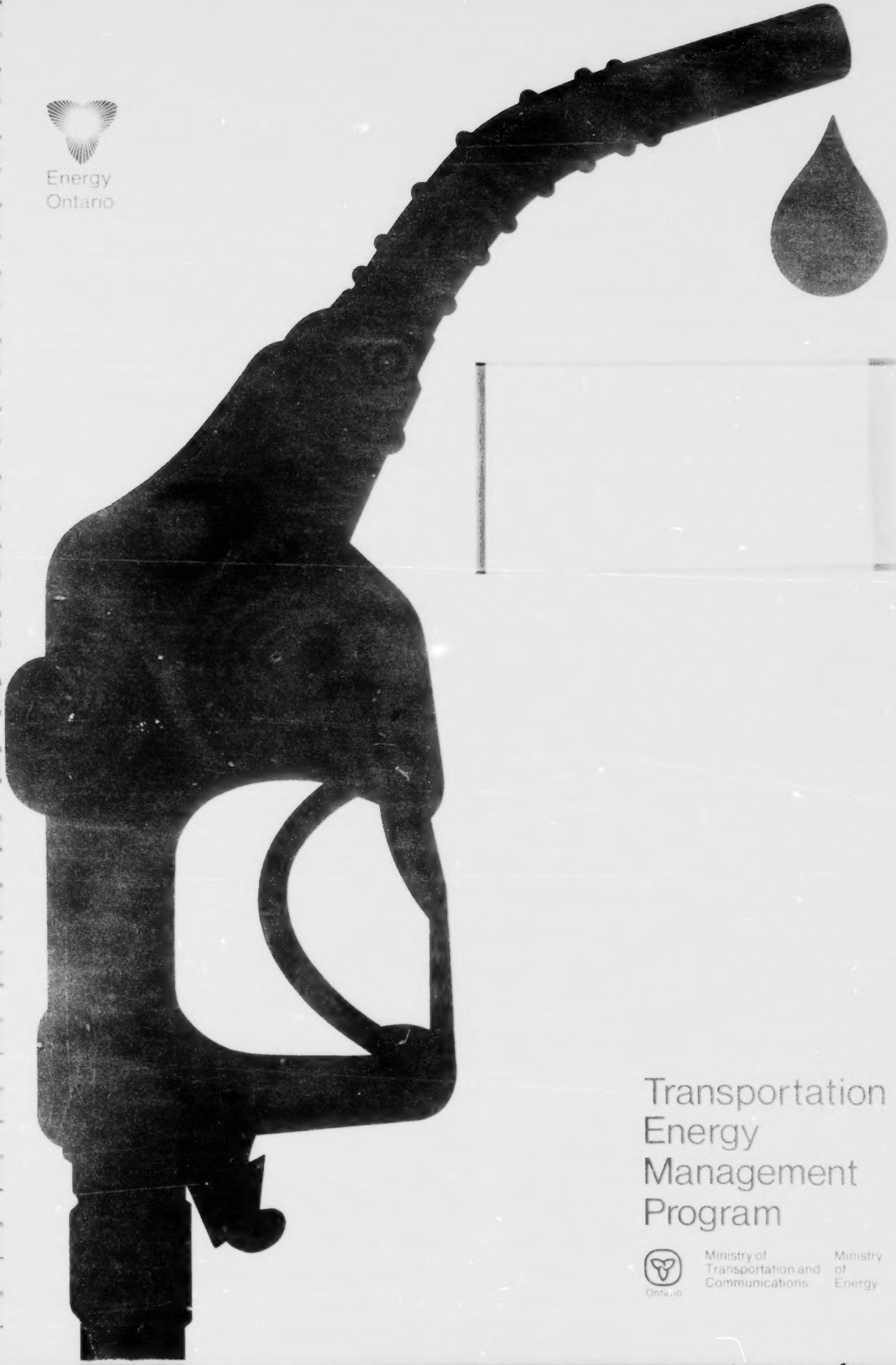
Energy
Ontario



Transportation Energy Management Program

Ontario

Ministry of Transportation and Communications

Ministry of Energy

TEMP-86-2-03

Alternative Transportation Operational Plan 86/87

TEMP-86-2-03

Alternative Transportation Operational Plan 86/87

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INTRODUCTION

Economic prosperity in Ontario depends strongly on the availability and efficiency of our transportation system which is still almost entirely dependent on gasoline and diesel fuel. Unfortunately the long-term supply, quality and price of these fuels remain uncertain - despite the apparent abundance presently enjoyed. Furthermore they are becoming increasinly undesirable due to health and environmental concerns which stem from the type and amount of pollutants emitted from gasoline and diesel engines. The stringent 1987, 1991 and 1994 US heavy-duty vehicle exhaust emission standards are a clear reflection of this concern.

The alternative fuels propane, natural gas and methanol present not only substantive solutions to above problems but also promise major economic benefits for Canada. These benefits will stem from the greater utilization of Canada's abundant natural gas resources and the establishment of alternative fuel industries with the potential of world exports. However, the realization of these benefits will necessitate major investments in new technologies.

At present, industry, government and research institutions are working together to meet these challenges. Fuels, engines and related infrastructure to meet or exceed the efficiency, performance, safety and environmental acceptability standards set by conventional fuels and vehicles over many decades of development have to be designed and demonstrated.

The Automotive Energy Section serves the TEMP program to provide technical and scientific support for the Ontario Government goals of reduced dependence on conventional petroleum resources, efficient transportation and industrial expansion. It consists of highly qualified engineers and scientists who are supported by MTC facilities including an EPA-type chassis dynamometer laboratory, a cold-soak chamber, a vehicle maintenance garage, fuel storage and handling facilities and analytical/electronic laboratories, and by ready access to MTC vehicle fleets. These capabilities uniquely qualify the section to devise, conduct and monitor in-house and external Research Development and Demonstration projects for the ATF Program in cooperation and consultation with private sector companies, research institutions and MENG.

The activities of the Section take the form of:

- Technology Development - Work in this category is, in general, designed to describe, adapt and improve upon existing technologies impacting the efficiency, performance, environmental acceptability, safety, reliability and related aspects of alternative fuel applications.

- Applied Research - Projects in this category involve, in general, development of new technologies and generation of technical/scientific data to permit the application of alternative fuels.

- Fleet Testing - These activities include testing of fuels, vehicles and related equipment in public and private sector fleets to establish long-term efficiency, reliability, serviceability, environmental impact, public acceptance and economics under actual operating conditions.

The proposed ATF Program for FY 86/87 includes projects of each type, which are organized for five program modules - Propane, Natural Gas, Alcohols, Diesel Substitution, and Automotive Energy General Modules. Within each module the projects are assigned to the Transportation Energy Technology Development and Fuels Research programs according to the purpose of each project. Each project is described by a comprehensive project summary sheet.

Transportation Energy Technology Program

The Transportation Energy Technology Program has been put together to demonstrate and develop transportation energy technologies with the final goals of reducing the use of petroleum and assisting the industry in Ontario.

The projects in this program have been selected to meet the following objectives:

- To develop a range of technologies which permit the efficient and increased utilization of alternative fuels.

- To demonstrate the use of alternative fuels in the automobile, truck and bus sector.

- To demonstrate new technologies associated with use of all alternative fuels.

- To develop new applications for alternative fuels in the marine, rail and agricultural sectors.

- To review and assess current fuel and engine technologies.

The budget request for this program for FY 86/87 is $660.0K.

Fuels Research Program

The Fuels Reseach Program has been devised to address the long term needs of the alternative transportation fuels sector. It is envisaged that the projects included in this program are the first steps in the traditional research, development and demonstration process. The objectives of this program are as follows:

- Conduct research to find new applications for alternative fuels.

- Conduct research to improve the utilization efficiency of alternative fuels.

- Conduct research into the basic characteristics of alternative fuels which could lead to novel ways of utilization.

- Review and study advanced and innovative fuel and engine technologies to assess their technological and economic feasibility.

The budget request for this program for FY 86/87 is $249.0 K.

ALTERNATIVE TRANSPORTATION FUELS

Budget 1986/87

Propane	$ 20.0K
Natural Gas	67.0
Alcohols	114.0
Diesel Substitution	647.0
Automotive Energy General	61.0
	909.0

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT PROJECTS

PROPANE PROGRAM

Propane is a by-product of natural gas processing, and crude oil refining which has been used as an automotive fuel in the United States, Europe, and Japan for many years. A system for its distribution exists across the country, and it is widely available in Ontario at retail fuel outlets. Conversions are occurring at a steady rate, largely in commercial fleets of light-duty vehicles. About 1.6% of gasoline in Ontario transportation has already been displaced by propane, making it the current major alternative fuel and the most important contribution to the long-term government goals of reduced dependency on oil.

In order to maintain this momentum, however, it becomes increasingly necessary to develop heavy-duty engine technologies for application in trucking and transit operations. Benefits to be derived are not only significant potential increase in propane use, but also possible solutions to pollutant emissions and noise level concerns with diesel engines. Declines in diesel-fuel quality, too, make it desirable to investigate fuel alternatives. Projects addressing this application of propane are included in the diesel substitution program.

It is also becoming obvious that there is a need for a second-generation technology for conversion equipment. Most of the equipment currently available lags behind recently developed gasoline-engine developments, and serious questions have been raised with regard to emissions, safety, efficiency and longevity of propane conversions.

The ATF propane program includes projects designed to meet these needs, working with the transportation and fuel industries to provide the technical understanding needed to maintain the industrial development and petroleum replacement generated by government incentives.

PROPANE PROGRAM

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT

31553	Technical Review and Assessment of Commercial Propane Conversion	$20.0K

Ministry of Transportation and Communications

Project Summary

Title: Technical Review and Assessment of Commercial Propane Conversion Methods	
Project No. 31553	Project Leader N. Perfect
Start Date: June 1986	Completion Date: March 1987
Current Fiscal Year: 1986/87	

Objective:

To provide technical assistance to the propane conversion industry for improving conversion methods.

Summary: It is proposed to review present propane conversion methods and and identify any areas in which improvements in either equipment or installation methods could be made. Tests will be conducted to demonstrate improvements.

Description of Activities/Planned Achievements:

1) Review available propane conversions equipment & methods of installation
2) Identify areas of possible improvement
3) Purchase samples of equipment shown from 1) and 2) to be susceptible to improvement.
4) Install in system, test, improve if practicable and retest
5) Final test to confirm results

Reason for Support:

Improvement of the state of the art of propane conversion equipment and methods of installation are necessary and feasible as demonstrated by the FY 85/86 MTC test program with private and public propane vehicles.

Previous Work:

Information available from exercise on effectiveness of propane conversion under project No. 31505

Supporting Organizations:

MENG, MTC, Centennial College

Post Project Activities:

Publish results and follow up with suppliers

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENG	Prov.	20K				
	Total	20K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Review of present equipment and installation methods	07 - 86	5
Identify potential improvement areas	07 - 86	6
Purchase equipment and install for test	08 - 86	10
Test and review results	10 - 86	14
Modify equipment as required	12 - 86	18
Retest to prove mods and remodify if reqd.	01 - 87	19
Final tests	02 - 87	20
Report	03 - 87	

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT PROJECTS

NATURAL GAS PROGRAM

The plentiful supply of indigenous natural gas in Canada provides an ideal opportunity for development of NGV, particularly in Ontario, with its strong demand for transportation fuel, and its excellent distribution network.

It is estimated that by 1995, propane and NGV together could account for 5% of transportation energy consumption Ontario, or nearly one-half of the province's total petroleum fuel displacement target.

Further research and development is necessary, however, to resolve a number of problems which currently limit the application of natural gas as a vehicle fuel.

Solutions must be found for the limited range of CNG vehicles, relatively poor performance in spark-ignition engines and the lack of diesel engine conversions.

At present, the only practical on-board fuel storage option for natural gas 3000 psi heavy steel or aluminum cylinders. Despite this higher pressure, typical CNG vehicles have a range of 75-150 km only. This problem is compounded by the scarcity of public fuelling stations and the relative inconvenience of the fuelling methods used. MTC and the Royal Military College have pioneered in the R&D for low-pressure storage systems, which may make home refuelling possible thus reducing many of the above problems and vastly expanding the availability of NGV. This R&D effort is now a joint program with Consumers' Gas and, it may, in future, see the cooperation of other gas utilities including some from Japan. It is anticipated that when low storage systems become available they will allow home-refuelling with small and relatively inexpensive compressors. In preparation for this eventuality, MTC will continue to assess commercial compressors by operating a prototype unit to fuel the NGV test vehicle.

The first generation NGV conversion kits were extensively evaluated at MTC during the last three years. These were found to be inadequate in realizing the full potential of natural gas as a superior fuel allowing for higher combustion efficiency and lower pollutant emission. Second generation conversion systems along with minor modifications to engines are being developed by industry in an effort to better match the characteristics of natural gas. MTC will continue these emerging technologies and provide a testing and evaluation service.

Development and demonstration of diesel conversion systems have become the main emphasis of the natural gas program. It is anticipated that successful conversions in the heavy-duty and medium-duty diesel vehicles will have a larger effect on total natural gas consumption and thus will justify larger investments in the NGV sector. This topic is more thoroughly covered in the diesel substitution program.

NATURAL GAS PROGRAM

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT

31507	Road Evaluation of CNG Conversion Systems	$10.0K
31520	In-use Evaluation of CNG Home Compressors	2.0
31563	Assessment of Cold-Start Performance of NG/Propane Vehicles	15.0
		27.0

FUELS RESEARCH

31509	Development of Improved and Cost Effective Carbon Adsorbents for Storing CNG	$40.0K

Ministry of Transportation and Communications

Project Summary

Title: NGV Vehicle Testing and Evaluation	
Project No. 31507	Project Leader: N. Perfect
Start Date: 86.04.01	Completion Date: 87.03.31
Current Fiscal Year: 86/87	

Objective: Assist Ontario industry in developing superior natural gas conversion equipment by supplying free testing and evaluation services.

Summary: In this project new NGV vechicle technologies, including microprocessor based carburation and ignition systems, will be evaluated with respect to their technical performance and potential economic impact.

Description of Activities/Planned Achievements:
- Acquire hardware, i.e., carburation and ignition systems, prototype engines, etc
- Install hardware on MTC vehicles
- Perform chassis dynamometer and road tests
- Prepare evaluation report(s)

Reason for Support: There is the continuing need to provide an impartial assessment of hardware and concepts developed either with government funding or totally independently by the private sector. MTC has the expertise and facilities to perform this function and thus to assist industry with developing new and better products.

Previous Work: This is a continuing function which has been performed by MTC and to some extent also by R&D organizations such as ORF and BCRC.

Supporting Organizations:

MTC

Post Project Activities:

- Review test results and possible improvements to hardware with industry
- Publish and disseminate project reports
- Promote successful hardware within and outside of government

Project Review

Regular quarterly reviews

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENG	Prov.	10				
MTC	Prov.	25				
	Total	35				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MTC request and experience with previous years' work

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Review new hardware	07 - 86	0
Assemble hardware	09 - 86	5.0
Perform test programs	02 - 87	7.5
Issue final project report	07 - 87	10.0

Ministry of Transportation and Communications

Project Summary

Title: In Use Evaluation of CNG Home Compressor	
Project No. 31520	Project Leader M. Tsang
Start Date: 04-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To assess and demonstrate the technical and economic feasibility of CNG home refuelling with commercially available small compressor.

Summary: MTC has purchased a state of the art small compressor. The unit was installed at MTC Reservoir. It will be used to refuel MTC natural gas vehicles. During the process, the operating parameters, maintenance and safety records of this compressor will be evaluated.

Description of Activities/Planned Achievements:

- Operate and maintain compressor over a one year period keeping detailed records of operating parameters (e.g. Hours of compressor operation, amount of fuel dispensed and electricity consumed, oil consumption maintenance and repair procedures)
- Produce an economic analysis
- Analyse data and prepare a project report

Reason for Support:

To assess and demonstrate the technical and economic feasibility of CNG home refueling with commercially available small compressor.

Previous Work:

Technical and economical analysis of CNG refuelling with small compressors at MTC (84/85)

Supporting Organizations:

Canadian Gas Institute

Post Project Activities:

Set up the RIX home compressor and obtain all the required authorization from Ontario Hydro and Pressure Vessels Safety Branch.

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENG	Prov.	2K				
	Total	2K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Compressor start up	4-7 - 86	
Data collection for compressor operation	8-12 - 86	2K
Report writing	12 - 86 to 3 - 87	

Ministry of Transportation and Communications

Project Summary

Title: Assessment of cold start performance of CNG and propane vehicles	
Project No. 31563	Project Leader: N. Perfect
Start Date: July 1986	Completion Date: March 1987
Current Fiscal Year: 1986/87	

Objective:
To assist industry in identifying the causes of and solutions to widely reported vehicle startability problems with natural gas and propane vehicles.

Summary: Operators of CNG and propane vehicles experience problems starting engines under cold conditions. No successful, practical solutions exist at the moment, and wider acceptance of CNG and propane dpends on eliminating these difficulties. The project will be aimed at finding solutions and implementing them.

Description of Activities/Planned Achievements:

1) Perform cold start tests on problem vehicles using refrigerated trailer at MTC
2) Test to identify causes of problems such as conversion equipment, fuel composition, vehicle components, calibration
3) Produce viable solutions to CNG and propane vehicle cold starting difficulties

Reason for Support:

To assist in overcoming cold starting problems which may result in wider use of propane and CNG as vehicle fuels

Previous Work:

Some tests done on MTC CNG vehicle during an earlier test program, but only as a means of getting vehicles going to check the fuel consumption

Supporting Organizations:

Equipment installers and suppliers

Post Project Activities:

Publish results and ensure that suppliers have all necessary information

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENG	Prov.	15K				
	Total	15K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Cold start tests of various vehicles	08 - 86	5
Testing of components	11 - 86	7
Possible modifications and testing	02 - 87	15
Report	03 - 87	

FUELS RESEARCH PROJECTS

Ministry of Transportation and Communications

Project Summary

Title: Development of Improved and Cost Effective Carbon Adsorbents for Storing Compressed Natural Gas on board Vehicles	
Project No. 31509	Project Leader D. Elliott
Start Date:	Completion Date: February 1987
Current Fiscal Year: 1986/87	

Objective: To generate and test new adsorbents capable of storing natural gas economically on board vehicles

Summary: Polymers such as Saran will be incorporated with commercial carbons to generate new adsorbents. The aim will be to prepare materials which are better or cheaper than straight Saran carbon in storing compressed natural gas of commercial purity.

Description of Activities/Planned Achievements:

- Prepare composite adsorbents using Saran or other polymers incorporated with commercial carbon products
- Investigate best packing modes including shaped blocks and pellets e.g. tetrahedra
- Investigate gas storage and delivery from selected materials when cycled repeatedly with commercial grade natural gas.

Reason for Support: Adsorbents are capable of storing CNG at much lower pressures (e.g. 500 psi) than conventionally used (3000 psi). If suitable materials can be made that will allow the use of natural gas as a transportation fuel to be greatly expanded.

Previous Work: In a program sponsored by MTC over several years, RMC have developed novel adsorbents for CNG. They were the first to identify and make new materials specially designed for CNG and are leaders in this development.

Supporting Organizations:

Consumers' Gas, MTC, MENG

Post Project Activities:

If suitable, moderate cost materials can be developed, they will be prepared in bulk quantities for installation in a test vehicle.

Project Review

RMC have long term experience in the theory of adsorption

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENG	Prov.	40	20			60
Consumers' Gas	Pri.	25	35			60
	Total	65	55			120

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

Equal shares between private and government support

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Proposal approved	07 - 86	
New materials made and characterized	10 - 86	20K
Selected materials made in bulk for scaled up tests	12 - 86	30
Cycling tests	02 - 87	55
Report	03 - 87	65

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT PROJECTS

ALCOHOLS PROGRAM

Methanol is an extremely attractive alternate fuel for transportation, due both to the relative ease with which it can be processed from Canadian natural gas, and the fact that, as a liquid, it is generally compatible with existing fuel storage and handling systems. Correctly blended mixtures of hydrocarbons and alcohols may be substituted for gasoline in unmodified vehicles, offering the advantage of an immediate, large-scale replacement of petroleum fuel. Alcohol may also be used as a blending agent to enhance octane, an application expected to become important as gasoline lead levels are reduced by current or impending legislation.

Although the prospects for alcohol fuels in Ontario seem good, a number of potential problems remain to be solved. One problem of particular concern to Canadians is that of cold-weather starting. Methanol has a high heat of vapourization, and vehicles using it as a neat fuel tend to require supplementary heat, volatile additives, and high cranking speeds, or a combination of all three, to start at low temperatures. There are also too many gaps in current knowledge of flammability characteristics of methanol containing hydrocarbons to develop optimum designs for engines and equipment to use them. Materials compatibility, engine durability and lubricant behaviour still require a great deal of further investigation, both for neat fuels, and blends intended for use in existing vehicles.

The Ford Motor Co., in cooperation with the Ontario Ministry of Energy and Energy, Mines and Resources Canada, has undertaken to design and build a small number of vehicles which will be capable of operating on a range of oxygenated fuels. These flexible fuel vehicles (FFV) will be a welcome contribution towards the marketing of high level alcohol blends. MTC will be an eager participant in the evaluation of this technology.

The present ATF alcohol program includes projects ranging from fleet tests in cooperation with industry to laboratory studies. Interest in these programs has been high, and some of the results obtained have already been responsible for private sector development and marketing programs.

ALCOHOL PROGRAM

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT

31503	MTC/SUNCOR/AGC Methanol/Gasoline Blend Vehicle Fleet Demonstration	$30.0

FUELS RESEARCH

31503	Evaluation of Fuel System Compatibility to Alcohol Blends	27.0
31511	MTC/Ford/Shell Methanol Vehicle Demonstration	27.0
31513	Straight Methanol Carburation, Cold-Start Performance	20.0
31571	Evaluation of Ford Multifuel Automobiles	10.0
		84.0

Ministry of Transportation and Communications

Project Summary

Title: MTC/SUNCOR/AGC/MVMA Methanol Blend Test Project	
Project No. 31503	Project Leader D. Elliott
Start Date: April 1, 1986	Completion Date: March 31, 1988
Current Fiscal Year: 1986/87	

Objective: To evaluate the acceptability of a methanol/ethanol/gasoline blend in the MTC fleet with respect to fuel consumption, emissions, reliability, durability and driveability. To examine the durability of component materials under fleet and laboratory conditions.

Summary: The use of ethanol as a cosolvent in methanol gasoline blends will be evaluated in new and used vehicles belonging to the MTC fleet. Fuel efficiency, performance and emissions will be measured by chassis dynamometer tests while driveability will be assessed in road tests. A separate lab-based project will look at the tolerance of fuel line related parts to the blend.

Description of Activities/Planned Achievements:

- New vehicles will be added to the existing MTC fleet.
- The fuel suppliers will supply a fully engineered methanol blend containing ethanol as cosolvent to reduce risk of phase separating.
- This fuel will be evaluated in the MTC fleet for its effect on fuel consumption, emissions and driveability.
- An auxiliary project will examine component durability under laboratory conditions.

Reason for Support:

MTC's testing of new ethanol blends will assist the fuel marketers - Suncor and AGC - to use ethanol confidently in their commercial fuel products. Future participation of MVMA members in this project will assist in gaining their support for the use of oxygenated fuels.

Previous Work:

MTC has been involved with the industry participants for 4 years, testing methanol containing fuels. Fleet tests at MTC have paved the way for the commercial introduction of such fuels in Ontario - V-Plus

Supporting Organizations:

MVMA, COFA, Suncor

Post Project Activities:

Project will last two years. Results will be published to elicit industry support for methanol blends.

Project Review

Original unsolicited proposal obtained from Suncor and AGC. Suncor, through US parent, has extensive experience in testing and marketing methanol blends

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY 87/88	FY	FY	Total
MTC	Prov.	45K	45			
MENG (Transp.Tech.)	Prov.	30	37.5			
MENG(Fuels)	Prov.	27				
Suncor	Pri.	40	40			
AGC	Pri.					
MVMA	Pri.	20	20			
	Total	162	142.5			

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

☐ Services ☐ Transfer Payment ☐ Other

How was the Ministry funding level determined?

Funding level determined by contributions made by each agency acting within its own areas of competance and ability.

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
6 new vehicles acquired	08 - 86	15.0
2 vehicles stripped and measured	09 - 86	17.0
1st Dyno/driveability tests	12 - 86	20.0
Lab tests of component durability	03 - 87	22.0
2nd Dyno/driveability tests	04 - 87	24.0
3rd Dyno/driveability tests	09 - 87	26.0
4th Dyno/driveability tests	03 - 88	28.0
2 vehicles stripped and measured	03 - 88	30.0

FUELS RESEARCH PROJECTS

Ministry of Transportation and Communications

Project Summary

Title: Durability Evaluation of Methanol Fueled Vehicles	
Project No. 31511	Project Leader D. Elliott
Start Date: April 1, 1986	Completion Date: March 31, 1987
Current Fiscal Year: 1986/87	

Objective: To evaluate the engine durability of a fleet of methanol vehicles exposed to methanol over an extended time period and the efficacy of specially formulated oils in minimizing engine wear.

Summary: A group of vehicles which has already been exposed to straight methanol fuel for some time over previous projects, will complete their mileage accumulation beyond 100,000 km. Direct measurement of engine wear and analysis of oils will enable the long term durability of these engines to be assessed when operated with special oil formulations.

Description of Activities/Planned Achievements:

- Seven methanol Escorts and two gasoline Escorts will be run on a long distance mileage accumulation for 2 years using oil formulations developed in a prior project.
- Oil samples will be taken regularly and analysed for trace wear metals and bulk property changes.
- After a total distance accumulation exceeding 100,000 km at the end of two year period, 4 vehicle engines will be stripped and measured for wear.

Reason for Support: In previous MTC sponsored projects, Shell Canada and Ford Canada have performed the most extensive evaluation to date of the long term durability of methanol engines. For a moderate continuing cost the in-use vehicles can be operated to nearly the end of their economic life and confirm the lubricant development already carried out.

Previous Work: In previous projects the two consultants devised new fuel mixtures for low temperature starting, investigated many different oil formulations and carried out intermediate range distance accumulation.

Supporting Organizations:

Project is jointly supported by Shell and Ford at 50% level.

Post Project Activities:

Disseminate project results to Canadian fuel, chemical and vehicle suppliers.

Project Review

Project was proposed by consultants and awarded because of their commitment

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY 87/88	FY	FY	Total
MTC)						
MENY)	Prov.	27.0	37.9			
Ford	Pri.	8.4	10.5			
Shell	Pri.	18.6	27.4			
	Total	54	75.8			

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

50% of total cost

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Vehicles stripped and measured	06 - 86	
Interim report	03 - 87	27K
Vehicles stripped and measured after complete accumulation	02 - 88	57K
Final report	03 - 88	75K

Ministry of Transportation and Communications

Project Summary

Title: Modelling of Methanol Engine Cold-Starting	
Project No. 31513	Project Leader David Elliott
Start Date: July 1986	Completion Date: August 1987
Current Fiscal Year: 1986/87	

Objective: To evaluate the cold start performance of the Ford flexible fueled engine under laboratory conditions and to develop a mathematical model of the process.

Summary: A Ford flexible fueled engine will be installed in a temperature controlled cell. It will be started and run under load on a range of fuel mixtures between gasoline and M85 (85% Methanol). Measurements of fuel input conditions will be monitored and used to develop a computor model of the carburetion process.

Description of Activities/Planned Achievements:

- Acquire FFV engine and mount with power absorption unit
- Determine the lowest starting temperatures for a range of fuel mixtures between gasoline and M85
- Warm up engine under load at few representative mixtures and temperatures e.g. 0, -10,-15°C and check for driveability faults
- Model cold start function under port fuel injection conditions and identify factors important in promoting cold startability and warm up.

Reason for Support:The flexible fuel vehicle is being developed by Ford under a separate project supported by the Ontario government. The present proposal will help to complement this development by giving access to the details of engine performance that can only be obtained easily in the laboratory. The Ford/Shell project is a fleet demonstration/oil development study only.

Previous Work: RMC have already carried out work on methanol engines under projects sponsored by MTC. This has included determining minimum cold start temperatures in a specially designed cold chamber developing models of the process and investigating the flammability characteristics of fuels containing methanol.

Supporting Organizations:

MTC, MEng, Ford, Shell

Post Project Activities:

Report will be prepared and circulated to supporting organizations to aid in modifying designs if necessary

Project Review

RMC were selected on the basis of their past experience and the facilities they have installed to perform cold chamber engine tests.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY 87/88	FY	FY	Total
M of Energy	Prov.	20K	27K			
	Total					

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

Full support

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Sign Contract with RMC	07 - 86	
Acquire Flexible Fuel Vehicle Engine From Ford	08 - 86	10K
Install engine in cold-chamber dynamometer	10 - 86	15K
Perform experiments	05 - 87	40K
Perform modelling study	07 - 87	45K
Final report	08 - 87	47K

Ministry of Transportation and Communications

Project Summary

Title: Evaluation of Ford Flexible Fuel Vehicle (FFV)	
Project No. 31571	Project Leader D. Elliott
Start Date: August 1986	Completion Date: March 1987
Current Fiscal Year: 1986/87	

Objective: To evaluate the fuel consumption,emissions, and driveability performance of a Ford flexible fuelled vehicle (FFV) on a range of fuels from 100% gasoline to 15% gasoline - 85% methanol blends.

Summary: A new prototype vehicle designed to run on any fuel mixture between gasoline and 85% methanol will be acquired. Performance will be evaluated of fuel consumption, emissions, equivalence ratio and driveability

Description of Activities/Planned Achievements:

- The vehicles will be tested on the chassis dynamometer on a range of fuel mixtures between gasoline and M85
- Emissions, fuel consumption and equivalence ratios will be determined.
- Road driveability tests will be carried out to check the adjustment of vehicles to fuels of different composition.

Reason for Support: The project will provide complementary information not duplicated by another project supported by MENY, FORD and SHELL, in which a fleet of FFV's will be examined for engine durability and acceptability under fleet operating conditions.

Previous Work: Previous work by FORD/SHELL and also by MTC has investigated the performance of FORD methanol vehicles. The FFV's have evolved from these and represent a considerable advance in supplying vehicles capable of using methanol or gasoline without adjustments.

Supporting Organizations:

MENY, MTC

Post Project Activities:

Results of this project will be communicated to Ford and Shell to assist them in the refinements of their products.

Project Review

Internal MTC project

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
MENY	Prov.	10				
MTC	Prov.	20				
	Total	30K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

Direct operating expenses only

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Acquisition of vehicle	07 - 86	
Chassis dynamometer testing	10 - 86	
Road testing	02 - 87	
Final report	03 - 87	

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT PROJECTS

DIESEL SUBSTITUTION PROGRAM

Demand for diesel fuel has been increasing steadily over the last decade taxing the production capacity of the existing North American petroleum refineries. This trend is expected to continue into the foreseeable future and may result in major supply/demand imbalances, lower diesel fuel quality and higher prices. These prospects are of major concern to industry and the government.

Public concern over the harmful effects of pollution resulting from diesel fuel combustion is also increasing, which is manifested by the more stringent heavy-duty vehicle exhaust emission standards enacted in the USA. These new standardsd will be difficult to meet without major technological breakthroughs or a switch to cleaner burning alternative fuels such as propane, natural gas and methanol.

Due to above reaons, major projects have been initiated in the diesel substitution area. Three of these involve extensive diesel substitution demonstrations with the transit industry which is especially vulnerable to future developments. The first demonstration involves the application of propane in Ottawa-Carelton Transpo, while the second and third application of compressed natural gas in Hamilton Street Railway and Mississauga Transit.

The first two demonstration are in full progress and are generating valuable technical experience, which may allow for an orderly and successful switch to propane or natural gas in large transit bus fleets.

In the OC and HSR demonstrations European engines are being employed due to the absence of a North American alternative. To remedy this situation MTC has established a partnership with Cummins Engines Co., Ontario Bus Industries and the Ontario Research Foundation to develop and demonstrate a North American natural gas bus engine. The selected baseline engine is the Cummins L-10, which is a recently introduced modern and efficient medium- to heavy-duty engine. The natural gas conversion of this engine will take place at ORF with the support of Cummins Engines Co., its engineering into a bus will be carried out by OBI, and Mississauga Transit is expected to be the first operator to demonstrate it. If successful, this technology shall not only reduce operating expenses, pollution and diesel consumption; but, it will also open new markets for OBI, Cummins Engines Co., conversion equipment suppliers and the Canadian natural gas industry.

The needs of the heavy-duty trucking sector are being addressed in a major demonstration project with ICG Liquid Gas Ltd. In this joint project which has the participation of Cummins Engines Co., Cummins Gas Engines, Western Star Truck, and ORF, the Cummins NTC 400 BIG CAM III engine will be further developed into a dedicated heavy-duty propane engine. The resulting technology will be applied to two ICG long-haul trucks one of which will serve as a demonstrator to be presented and loaned to the trucking industry while the second is put into regular ICG truck applications.

DIESEL SUBSTITUTION PROGRAM

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT

31500	OC Transpo Propane Bus Demonstration	$63.0K
31517	HSR Natural Gas Bus Demonstration (Phase II)	65.0
31551	ICG Propane Truck Demonstration	119.0
31559	Conversion of Medium-Duty Diesel Engine to Natural Gas	75.0
31560	Natural Gas Conversion and Testing of 8.2 L Detroit Diesel	100.00
31564	Technical Assessment of NG/Diesel Fuel Conversions	40.0
31568	Methanol Bus Demonstration and Road Service Evaluation	50.00
31577	Development and Optimization of DERECO Propane and Natural Gas Engines	60.0
31580	Mississauga Transit Natural Gas Bus Demonstration	0.0
		572.0

FUELS RESEARCH

31579	Methanol Use in Large Engines	75.0

Ministry of Transportation and Communications

Project Summary

Title: OC Transpo Propane Bus Demonstration

Project No. 31500	Project Leader: J. Turner
Start Date: April 1, 1985	Completion Date: March 31, 1987

Current Fiscal Year: 86/87

Objective: To demonstrate the practicality of operating a fleet of propane-powered transit buses. Obtain information on reliability, operating costs and public acceptance.

Summary: A total of 10 buses were converted to operate on propane fuel and entered into revenue service at OC Transpo. The engines were converted by DERECO and are fueled from an on-site bulk storage facility. Beginning this fiscal year revenue service will continue for a total of two years, during which time information concerning the economics and durability of the propane vehicles will be generated.

Description of Activities / Planned Achievements:

1. The ten buses were fitted with propane engines, fuel tanks and associated hardware.
2. An on-site propane storage and fueling facility was installed at OC Transpo.
3. An information gathering/processing system was designed and installed at OC Transpo to handle propane bus related information during operation.
4. One propane bus was tested for relative noise and vibration levels compared to the standard diesel-powered vehicles.
5. All buses were entered into revenue service, where they will be monitored until the end of the project.

Reasons for Support: Because of the past volatility exhibited by diesel supply, prices and quality, it is considered prudent to investigate/establish alternative means of fueling Ontario's transit buses with indigenous fuels such as propane and natural gas. The purpose of this demonstration is to demonstrate the feasability and economics involved in the conversion of buses in a typical transit operation to an alternative fuel.

Previous Work: None.

Account #: 15-31500

Supporting Organizations: MTC, Min. of Energy, Energy, Mines and Resources

Post Project Activities: The information gathered during this program will enable other transit fleets to determine the economic viability of propane in their buses. Although future demonstrations will most likely involve North American propane engines, the economic information generated by this project will be of great relevance.

Project Review: Regular (monthly) meetings with OC Transpo in addition to regular (approximately bi-monthly) steering committee meetings are planned.

PROPOSED FUNDING

Contributors	Type	FY 85/86	FY 86/87	FY	FY	Total
Min. of Energy	Prov	$ 62.3k	$ 72.7k			$ 135 k
EMR	Fed	$ 62.3k	72.7k			135 k
OC Transpo	Pri	$103.8k	121.2k			225 k
	Total	$ 228.4k	$ 266.6k			$ 495 k

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [x] Transfer Payment [ ] Other

How was the Ministry funding level determined ? This project is the continuation of a previous phase. Funding levels (both government and private) were based upon those established in the prior phase.

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
All 10 buses in revenue service	4 - 86	62.3
End of 1st quarter - bus demonstration	6 - 86	65
End of 2nd quarter - bus demonstration	9 - 86	75
End of 3rd quarter - bus demonstration	12 - 86	95
End of 4th quarter and bus demonstration	3 - 87	135
Reports completed by OC Transpo	6 - 87	135

Ministry of Transportation and Communications

Project Summary

Title: HSR Natural Gas Bus Demonstration - Phase 2	
Project No. 31517	Project Leader D. Petherick
Start Date: 04-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective: To evaluate the technical and economic desirability of operating a fleet of natural gas powered buses in Ontario.

Summary: This demonstration will evaluate the feasibility and economics of operating a fleet of natural gas powered transit buses. Information on reliability, operating costs, and public acceptance will be gathered.

Description of Activities/Planned Achievements:

- Convert 5 more buses to natural gas
- Collect and report the operating experience with the natural gas buses and the refuelling facility
- Conduct rider and driver surveys
- Coordinate publicity efforts and issue a project report

Reason for Support:

Canada has a large surplus of natural gas which is priced at a much lower level than diesel fuel. It can be beneficially employed to reduce our dependence on diesel fuel. Natural gas engines are low polluters (low particulates) and quieter than diesels which are major benefits in urban areas.

Previous Work:

Phase one - Construction of refuelling facility
- Installation of IVECO diesel and natural gas engines in buses
- GO/NO GO testing

Supporting Organizations:

Ontario Research Foundation
Union Gas Company

Post Project Activities:

Disseminate information resulting from the demonstration to promote the use of compressed natural gas as a transit bus fuel. Consider conversion of a larger HSR fleet to natural gas.

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
M. of Energy	Prov.	65				
EMR	Fed.	70				
HSR	Mun.	70				
Union Gas	Pri.	4				
	Total	229				

*Note: Union Gas have contributed $200K for compressor which is on loan to HSR.

"Type" Legend: Prov - Provincial Govt.,Fed - Federal Govt.,Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Receive remaining 5 engines	06 - 86	-
Install engines in buses	09 - 86	20K
Install fuel metering device on compressor	08 - 86	30K
Field performance monitoring	01 - 87	40K
Data analysis completed	02 - 87	50K
Phase 2 report completed	03 - 87	65K

Ministry of Transportation and Communications

Project Summary

Title: ICG Propane Truck Demonstration

Project No. 31551	Project Leader: J. Turner
Start Date: January 1, 1986	Completion Date: March 31, 1988

Current Fiscal Year: 86/87

Objective: To demonstrate a domestic diesel engine, converted to run on propane, in a class 8 heavy-duty highway tractor. Two tractors will be converted; the first will enter revenue service in ICG's fleet. The second will be a show truck, to be entered in truck shows, conferences and seminars and will also be loaned out, for short periods of time, to prospective propane truck operators.

Summary: Two class 8 heavy-duty highway tractors will be converted to propane using converted Cummins 350 hp diesel engines. ORF will perform the engine conversions. Engines will be installed into new Western Star tractors at the factory in Kelowna, B.C. The tractors will be owned by ICG. One of them will be used for publicity while the second will transport bulk propane.

Description of Activities / Planned Achievements:

1. Convert the first tractor to propane using the engine developed as part of an earlier program.
2. Develop a second (new) engine at ORF and install it into the second tractor.
3. Rebuild a third engine at a heavy engine rebuild shop to propane specifications. This engine will be swapped with the original engine which was in the first tractor.
4. Both tractors will enter ICG fleet operation and publicity campaign upon completion.

Reasons for Support: To develop a second generation heavy-duty propane engine and obtain long-term fleet-operating experience in the areas of operating cost, durability, and efficiency. This program will carry out the necessary ground work which will enable widespread conversion of heavy trucks to propane.

Previous Work: An earlier phase (II) involved the development of a first generation heavy duty truck engine. This engine was installed in a new 1985 Western Star tractor and operated by Manitoulin Transport in revenue service for a period of seven months.

Account #: 15-31551

Supporting Organizations: MTC, Min. of Energy, ICG, Cummins Diesel Engines, and Cummins Gas Engines, Western Star Trucks Inc.

Post Project Activities: The Phase II engine will be suitable for sale and installation either as new or reconditioned from a used diesel engine to propane fueling. These engines may be installed in new or used trucks operating in fleets province wide by heavy engine repair shops with the expertise obtained in this project.

Project Review: Regular (monthly) meetings with ORF and ICG staff involved in the program.

PROPOSED FUNDING

Contributors	Type	FY 85/86	FY 86/87	FY 87/88	FY	Total
Min. of Energy	Prov	$ 30,000	$119,000	$ 56,500		$205,500
ICG	Pri		230,000			230,000
Cummins Diesel	Pri		9,000			9,000
Cummins Gas	Pri		15,000			15,000
Western Star	Pri		2,000			2,000
	Total	$ 30,000	$375,000	$ 56,500		$461,500

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [x] Transfer Payment [ ] Other

How was the Ministry funding level determined ? Ministry funding pays only for engine development work. All other costs born jointly by private industry.

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Install existing (Phase 1) engine in first new, ICG tractor	6 - 86	
Enter first truck into ICG service and publicity campaign		
Refine first Phase II engine from Cummins Gas Engines, on ORF Dynamometer		
Install first Phase II engine into second new, ICG tractor		
Enter second ICG tractor into revenue service at ICG		
Rebuild a used Cummins diesel block to ORF specs. To produce the second Phase II propane engine		
Swap the Phase I engine with the second Phase II engine in the first ICG tractor		
Enter first ICG tractor into service with second Phase II propane engine		
Prepare and issue final report	3 - 87	

Ministry of Transportation and Communications

Project Summary

Title: Conversion of Medium-Duty Cummins L10 Diesel Engine to Natural Gas	
Project No. 31559	Project Leader D. Petherick
Start Date: 06-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To develop a reliable medium-duty natural gas engine to displace some of diesel fuel used by medium-duty trucks and buses.

Summary: To-date, natural gas has not been able to penetrate the truck and bus sectors due to the absence of proven engine conversions which would perform well in these demanding applications. The Cummins Engine Co. has offered their cooperation in conversion of the L10 medium duty diesel engine to natural gas. This natural gas engine will be suitable for buses and trucks.

Description of Activities/Planned Achievements:

- Commission R&D organization to conduct project
- Acquire a Cummins L10 engine and test it to establish baseline performance
- Perform conversion to natural gas (cylinder head, pistons, ignition,etc)
- Document conversion and test results

Reason for Support:

- A reliable NG engine is required to displace some of the diesel fuel used by medium duty trucks and buses.

Previous Work:

Past experience with other heavy-duty NG engines (IVECO)

Supporting Organizations:

Ministry of Transportation and Communications

Post Project Activities:

Install L10 CNG engines in trucks and buses as part of demonstration/ proveout. Promote Ontario manufacturing facility to produce these engines for Canada and export.

Project Review

ORF has the facilities and expertise to effectively perform the required tasks. Substantial Cummins Engine Co. commitment and contribution has been secured.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
M of Energy	Prov.	75				
Cummins Engine Co.	Pri.	140				
	Total	215				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Acquire engine	06 - 86	
Baseline testing completed (diesel)	09 - 86	15
Engine conversion to natural gas completed	11 - 86	20
Natural gas testing completed	01 - 87	35
Optimization work completed	01 - 87	55
Data analysis completed	02 - 87	65
Final report completed	03 - 87	75

Ministry of Transportation and Communications

Project Summary

Title: Natural Gas Testing and Conversion of an 8.2 L Detroit Diesel Engine

Project No. -31560	Project Leader: J. Turner
Start Date: April 1, 1986	Completion Date: March 31, 1987

Current Fiscal Year: 86/87

Objective: To develop a durable, compact, domestic natural gas engine suitable for operation in either transit or medium duty truck applications.

Summary: An 8.2 Litre Detroit Diesel Allison (DDA) engine will be converted to natural gas and optimized on a computer-controlled dynamometer. The object of the exercise is to produce a durable natural gas engine, suitable for use in medium duty truck or transit bus applications. The 8.2 DDA engine is particularly suited to this application because it is a compact, low cost diesel which has been installed in a 40 ft bus on a trial basis by GMC.

Description of Activities / Planned Achievements:

1. The 8.2 L engine will be converted to run on natural gas by reducing compression ratio, installing hardened valves and seats, and mounting natural gas fuel system and electronic ignition system.
2. The converted engine will be installed on a computer-controlled dynamometer at ORF for optimization of mixture and spark schedules on natural gas.
3. The optimized engine will be run on modified ADB cycles to estimate on-road fuel efficiency.

Reasons for Support: Because of the need for a domestically produced natural gas engine for transit and medium duty trucking. This engine is relatively inexpensive, compact and since it was originally designed as a medium-duty diesel should have adequate durability.

Previous Work: Detroit Diesel previously performed some work on the 8.2 L engine in propane trim. Although the program was apparently a success, the engine has never been marketed (probably because the market for such a propane engine would have been limited).

Account #: 15-31560

Supporting Organizations: MTC and Min. of Energy

Post Project Activities: The 8.2 L natural gas engine would be a prime candidate for further demonstration in a truck or bus upon completion of this project.

Project Review: Regular (monthly) meetings with ORF staff involved in the program.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
Min. of Energy	Prov	$100.0k				$100.0k
General Motors	Pri	$?				
	Total	$100.0k				$100.0k

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [x] Transfer Payment [ ] Other

How was the Ministry funding level determined ?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Obtain one diesel 8.2 L engine and associated conversion components	8 - 86	25
Convert 8.2 L engine block to run on natural gas	10 - 86	40
Install engine on computer-controlled dynamometer at ORF	11 - 86	50
Optimize engine for natural gas, on dynamometer	1 - 87	75
Perform modified ADB cycles on engine	2 - 87	90
Remove engine from dynamometer and prepare final report	3 - 87	100

Ministry of Transportation and Communications

Project Summary

Title: Technical Assessment of NG/Diesel Dual Fuel Conversion	
Project No. 31564	Project Leader D. Petherick
Start Date: 06-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

Assess the technical status of commercial NG conversion system for medium-duty diesel engines employing NG/diesel dual fuelling.

Summary: An assessment of the technical status of commercial NG conversion systems for medium duty diesel engines employing NG/diesel dual fuelling is required.

Description of Activities/Planned Achievements:

- Select suitable consultant
- Acquire test engine and three conversion systems
- Conduct engine dynamometer tests to establish baseline performance with diesel fuel
- Conduct three series of tests to determine the performance of the three conversion systems
- Optimize parameters to minimize energy consumption, maintaining performance
- Prepare project report

Reason for Support:

Low natural gas prices are providing some incentive for medium-duty truck and bus operators to switch to CNG but technical support needs improvement. The concept of diesel pilot injection ignition of natural gas requires detailed study to assess the merits of this technique versus a spark ignition conversion.

Previous Work:

Supporting Organizations:

Ministry of Transportation and Communications

Post Project Activities:

Based on project results either;

1/ Terminate further diesel-pilot injection work
2/ Demonstrate the technology on a bus or truck

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
M of Energy	Prov.	40				
OEM	Pri.					
	Total					

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Obtain engine	09 - 86	
Obtain 3 conversion systems	09 - 86	
Baseline diesel performance testing complete	10 - 86	
Conversion systems evaluation complete	12 - 86	
Optimization work complete	01 - 87	
Data analysis complete	02 - 87	
Project report complete	03 - 87	

Ministry of Transportation and Communications

Project Summary

Title: Methanol Bus Demonstration and Road Service Evaluation	
Project No. 31568	Project Leader D. Petherick
Start Date: 06-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To assess the technical, environmental and economic desirability of operating transit buses on methanol fuel in Ontario. The participants of this project will include OBI, ORF and a transit property.

Summary: The MAN methanol engine will be engineered into an OBI bus for on the road evaluation purposes. This engine represents the state-of-the-art and most developed methanol engine. It will provide for an excellent evaluation of the fuel and the technology. The vehicle will be operated by a transit company.

Description of Activities/Planned Achievements:

- Find suitable transit company
- Construct refuelling facility at transit company
- Install/engineer engine into an OBI bus
- Evaluate engine performance vs diesel via comparison of data from bus engine testing program at ORF and with actual on the road testing (Blainville, P.Q.)
- Operate bus in transit fleet for 1 year - produce report

Reason for Support: Methanol is one of the promising replacements for diesel fuel and helps reduce urban transit bus pollution (especially particulates). At the conclusion of this test, a well-developed engine will have been evaluated in Ontario operating conditions providing an accurate assessment of the state of methanol engine technology/feasibility.

Previous Work:

Bus engine testing at ORF (1985/86 FY)

Supporting Organizations:

MTC

Post Project Activities:

Promote the use of methanol in large engines to displace diesel and and reduce particulates. Transfer technology to Cummins L10 methanol development program.

Project Review

OBI is an Ontario manufacturing company capable of supplying Canadian and international markets with buses running on alternative fuels. ORF is familiar with cold weather vehicle testing at Blainville, P.Q.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
M. Energy	Prov.	50				
AGCL	Pri.	10(?)				
OBI	Pri.	10(?)				
Transit Co.	Pri.	10(?)				
	Total	80				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Engineer engine into bus	10 - 86	
Refuelling facility completed	12 - 86	
Cold weather road testing completed	03 - 87	
Interim report completed	03 - 88	
Transit operation completed	03 - 88	
Data analysis completed	02 - 88	
Final report completed	03 - 88	

Ministry of Transportation and Communications

Project Summary

Title: Development and Optimization of DERECO Propane and Natural Gas Engines

Project No: 31577	Project Leader: J. Turner
Start Date: April 1, 1986	Completion Date: March 31, 1987

Current Fiscal Year: 86/87

Objective: To determine the optimum operating mode for the DERECO propane and natural gas bus engines. This information will be used to ensure that the engines operating in the field are running at peak efficiency.

Summary: DERECO propane and natural gas engines will be optimized at ORF on a computer-controlled engine dynamometer. In addition to determining optimum mixture and spark advance schedules, a number of concerns which have arisen in the bus demonstration programs will be investigated (such as the need for a PCV system on the engine in its spark-ignited form).

Description of Activities / Planned Achievements:

1. One propane and one natural gas engine (both DERECO) will be installed on a computer-controlled engine dynamometer at ORF - one at a time.
2. Each engine will be optimized on its respective fuel under similar conditions to those experienced in the bus engine compartment.
3. Additional testing will also be performed on the engines based upon experiences received in the ATF transit bus demonstrations which use the same engines.
4. The engines will be set up with the best possible set-ups (as determined in the above steps, and run on the dynamometer under simulated engine operating conditions (using the ADB cycle). This step will provide information on the relative engine operating efficiency (before and after figures will be available for comparison).

Reasons for Support: Because both of these engines are currently in service in provincial transit operations, and because some problems have been experienced with the engines while in service, it is desirable to verify that their existing operating parameters complement the environments in which they are operating. This program will provide this information, possibly yielding a more fuel efficient, longer lived ATF engine for the transit industry.

Previous Work: These engines were originally converted and optimized by DERECO before installation into the buses. As has been discovered since, anumber of problems, inherent in the original conversion have become apparent in these demonstrations. It is now very likely that as a result of experiences with the engines in service that the original work performed by DERECO, used in setting up the engines, may now be obsolete.

Account #: 15-31577

Supporting Organizations: MTC and Min. of Energy

Post Project Activities: Engine set-up parameters determined from the project work may be incorporated into the existing ATF bus projects to improve the performance of the in-field equipment and the quality of the results obtained from these demonstrations.

Project Review: Regular (monthly) meetings with ORF staff involved in the program.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
Min. of Energy	Prov	$60.0K				$60.0K
	Total	$60.0K				$60.0K

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [x] Transfer Payment [ ] Other

How was the Ministry funding level determined ?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Install propane engine on Dynamometer	7 - 86	0
Complete testing of propane engine	10 - 86	20
Remove propane engine/installing engine	11 - 86	30
Complete testing of NG engine	2 - 87	45
Complete final report	3 - 87	60

Ministry of Transportation and Communications

Project Summary

Title: Mississauga Transit Natural Gas Bus Demonstration	
Project No. 31580	Project Leader D. Petherick
Start Date: 04-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To demonstrate the practicality of operating transit buses on natural gas by using a North American engine. Obtain information on efficiency, reliability, economics and public acceptance.

Summary: This is a natural gas demonstration to be conducted by Mississauga Transit in cooperation with OBI, Consumers' Gas, Fiba-Canning ORF, MTC and MENG. It will provide the first major experience with North American medium- to heavy-duty natural gas engines in buses.

Description of Activities/Planned Achievements:

- Obtain engine
- Engineer engine into an OBI bus
- Perform operational road testing/prove out (ORF)
- Operate the bus in the Mississauga Transit fleet
- Obtain operational data
- Produce report

Reason for Support:

The need to enhance efficiency in Ontario transit operations and the need to establish technical and economic status of North American natural gas engines

Previous Work:

HSR and OC Transpo demonstrations

Supporting Organizations:

OBI	Consumers' Gas
ORF	Fiba Canning
Mississauga Transit	

Post Project Activities:

Based on demonstration results, promotion of the use of this engine in suitable applications will be pursued

Project Review

Obi is an Ontario manufacturing company capable of syupplying Canada and International markets with alternative fuelled buses

PROPOSED FUNDING

Contributors	Type	FY	FY	FY	FY	Total
M Energy	Prov.					
Consumers' Gas	Pri.					
Fiba-Canning	Pri.					
Mississauga Transit	Pri					
	Total					

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Obtain engine	07 - 86	
Engineer engine into OBI bus	09 - 86	
ORF completes bus testing	11 - 86	
Mississauga operates transit bus	03 - 87	
Program monitoring completed (1986 FY)	03 - 87	
Interim report completed	03 - 87	
Program monitoring completed (FY 1987)	03 - 87	
Data analysis completed	01 - 88	
Final report completed	03 - 88	

FUELS RESEARCH PROJECTS

Ministry of Transportation and Communications

Project Summary

Title: Development and Testing of Large Methanol Engines	
Project No. 31579	Project Leader: D. Petherick
Start Date: 06-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To advance the medium- and heavy duty methanol engine technology in cooperation with the Cummins Engine Co.

Summary: With the involvement of Cummins Engine Co. a modified L10 diesel engine will be operated and tested using a cetane improved methanol fuel. Engine performance, fuel consumption, and emissions will be evaluated on the engine dynamometer.

Description of Activities/Planned Achievements:
- Obtain first generation methanol engine (requiring cetane improver)
- Obtain fuel/cetane improver
- Install engine on dynamometer
- Evaluate performance, emissions fuel consumption
- Carry out hardware and calibration mode functions
- Test second generation engine
- Perform single-cylinder research and produce second report

Reason for Support:

Methanol is one of the promising replacements for diesel fuel and helps reduce urban transit bus pollution (especially particulates).

Previous Work:

Cummins have developed a first-generation L-10 methanol engine. However, this engine will need development and testing before it can be put into a critical application, such as a transit bus.

Supporting Organizations:

MTC

Post Project Activities:

Based on parallel MAN work/testing, develop a spark or glow plus assisted L10 capable of operating on neat (100%) methanol without cetane improver. Install cetane-improved L10 in a suitable vehicle to evaluate real-world operation.

Project Review

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
M. Energy	Prov.	75K				
Cummins Engine Co.	Pri.	110K				
EMR	Fed.	75K				
	Total	260K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Obtain engine (L10)	07 - 86	
Modify L10 as required	11 - 86	
Engine dyno testing of L10 completed	01 - 87	
Data analysis completed	02 - 87	
Final report completed	03 - 87	
Obtain single-cylinder research L10 engine	11 - 87	
Perform single-cylinder evaluation of spark-assist or glow-plug assist tech.	03 - 87	

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT PROJECTS

TRANSPORTATION ENERGY - GENERAL PROGRAM

The general program includes a project with Ontario Provincial Police to demonstrate the aerodynamic light bar which was developed in the past fiscal year, and a joint program with the New York State Energy Research and Development Agency (NYSERDA) and ORF to develop and demonstrate particular traps for transit buses. The particulate trap technology is one of the few, if not the only, potential solution to the diesel particulate emission problem which is becoming the subject of even tighter federal standards. The availability of this technology will allow retrofitting of existing buses until a more satisfactory solution, such as propane, natural gas or methanol engines, become available.

TRANSPORTATION ENERGY - GENERAL PROGRAM

TRANSPORTATION ENERGY TECHNOLOGY DEVELOPMENT

31519	Aerodynamic Devices for Police Cruiser	$5.0K
31581	Vehicle Performance Simulation	6.0
		11.0

FUELS RESEARCH

31574	Development of Particulate Traps for Diesel Trucks and Buses	$50.0K

Ministry of Transportation and Communications

Project Summary

Title: Aerodynamic Devices For Police Cruisers

Project No. 15-31519

Project Leader: J. Turner

Start Date: April 1, 1985

Completion Date: March 31, 1987

Current Fiscal Year: 86/87

Objective: To develop and demonstrate equipment to reduce aerodynamic drag on police cruisers equipped with lightbars.

Summary: Work will be performed on the prototype lightbar to reduce the noise level in the vehicle to that comparable to existing OPP automobiles equipped with conventional lightbars. The prototype lightbar will then be assessed by the OPP to determine the acceptability of the equipment to the personnel using it. When approval has been received by the OPP, twelve prototype lightbars will be constructed and installed on twelve new OPP police automobiles. These vehicles are to be entered into actual operation in the OPP fleet alongside twelve identical vehicles equipped with the conventional OPP lightbar for comparison.

Description of Activities / Planned Achievements:

1. Refine the prototype lightbar to reduce noise emissions.
2. Install first prototype onto new police vehicle and enter into trial service in a typical OPP detachment for a period of at least six weeks for assessment.
3. Upon receiving approval by the OPP of the new lightbar, construct an additional eleven lightbars and install them on an additional eleven police vehicles.
4. The twelve vehicles equipped with prototype lightbars will be entered into service alongside twelve identical vehicles equipped with conventional OPP lightbars for in-service comparison of their respective fuel efficiencies and performance in service.

Reasons for Support: The exisitng OPP lightbar, while having excellent sound and light transmitting capabilities, is very aerodynamically inefficient. The proposed prototype lightbar utilizes basically the same lights and siren as the existing lightbar but is arranged in a much more fuel efficient manner on a much "cleaner" platform. Significant savings of fuel will be realized if the program is successful.

Previous Work: None.

Account #: 15-31519

Supporting Organizations: MTC and Min. of Energy

Post Project Activities: The prototype lightbar, if successful, would probably be gradually incorporated into the OPP fleet. The existing lightbars would be traded-off in favour of the new design.

Project Review: Regular meetings with OPP staff involved in the program.

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY	FY	FY	Total
Min. of Energy	Prov	$ 5.0k				$ 5.0k
	Total	$ 5.0k				$ 5.0k

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [x] Transfer Payment [ ] Other

How was the Ministry funding level determined ?

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Equip one OPP vehicle with prototype lightbar and enter into fleet service for preliminary evaluation	8 - 86	0
Upon satisfactory completion of preliminary evaluation, construct and install remaining 11 lightbars on OPP vehicles	8 - 86	5
Enter 24 OPP vehicles into fleet service for 6 month period - 12 equipped with prototype lightbar, 12 with standard OPP bar	9 - 86	
Complete demonstration, write report, make recommendations concerning future use of prototype lightbar	3 - 87	

Ministry of Transportation and Communications

Project Summary

Title: Vehicle Performance Simulation (HEVSIM)	
Project No. 31581	Project Leader: M. Tsang
Start Date: 07-01-86	Completion Date: 03-31-87
Current Fiscal Year: 1986/87	

Objective:

To determine efficiency of engines and vehicles used in demonstration programs on selected routes by computer simulation.

Summary: MTC has obtained the latest version of a large computer simulation program which allows prediction of fuel consumption, performance, and exhaust emissions of large vehicles. It will be used to complement the engine testing data and road experience of the OC Transpo and HSR bus fleets (propane/natural gas). Computer simulation is a very cost effective method of performing the required data analysis.

Description of Activities/Planned Achievements:

- Convert original DOT program (HEVSIM) from DEC-10 to IBM format
- Prepare engine performance maps from experimental data
- Conduct simulation runs
- Conduct field verification trials
- Analyse and report results

Reason for Support:

Enhancement of engine dynamometer and road data from the OC Transpo and HSR propane/natural gas bus demonstration programs.

Previous Work:

Bus engine testing at ORF (1985/86 FY)

Supporting Organizations:

HSR
OC Transpo
ORF

Post Project Activities:

Continued program development will result in a transit advisory service to analyse projected savings using alternate fuels. This will help promote diesel substitution as real work verification trials will also be performed.

Project Review

The capability to perform this work exists in-house at MTC. (No consultants required)

PROPOSED FUNDING

Contributors	Type	FY	FY	FY	FY	Total
MTC	Prov.	3K				
MENG	Prov.	3K				
	Total	6K				

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

[ ] Services [X] Transfer Payment [ ] Other

How was the Ministry funding level determined?

Cost of computing services and student time. (Internal project)

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Convert existing program to IBM format	08 - 86	1.0
Engine performance maps prepared	09 - 86	2.0
Simulation Runs Completed	12 - 86	3.0
Field verification trials completed	12 - 86	4.0
Analysis of data completed	01 - 87	5.0
Final report completed	03 - 87	6.0K

FUELS RESEARCH PROJECTS

Ministry of Transportation and Communications

Project Summary

Title: Development of traps to reduce particulate emissions from diesel engines	
Project No. 31574	Project Leader: D. Elliott
Start Date: July 86	Completion Date: October 87
Current Fiscal Year: 1986/87	

Objective:

To develop a diesel particulate trap and associated regenerating system capable of being installed on trucks and buses.

Summary: A particulate trap and control system will be designed and tested, capable of being fitted to DDA 6V71 diesel bus engines and capable of operating under a representative bus operating cycle.

Description of Activities/Planned Achievements:

- Test 6V71 engine on a dynamometer with catalysed ceramic traps to determine particle accumulation rates over bus cycle
- Design fit and program control system to reduce accumulations to acceptable level
- Install system in two transit buses and operate locally to assess performance
- Deliver buses to cooperating transit authorities (NY and Toronto) and monitor performance

Reason for Support:

The project may lead to singificant commercial development by Ontario industry with export possibilities. Major support is already offered by US agencies and companies.

Previous Work:

ORF have performed research in trap technology. They have established the limitation of plain traps in light duty operation and the need for an auxillary regeneration system.

Supporting Organizations:

New York State Energy Research & Development Authority
Englehard Corp.
Corning Glass

Post Project Activities:

Project Review

ORF were chosen because of their experience in the field and the confidence they have generated in their proposed solution to an important environmental problem

PROPOSED FUNDING

Contributors	Type	FY 86/87	FY 87/88	FY	FY	Total
MENG	Prov.	50	30			80
Nyserda) Corning) Englehard)	Pri.	80	80			160
	Total	130	110			240

"Type" Legend: Prov - Provincial Govt., Fed - Federal Govt., Pri - Private Sector

Ministry Funding Type:

☐ Services ☐ Transfer Payment ☐ Other

How was the Ministry funding level determined?

Funding level is balance of support after US agencies

MILESTONES AND CASHFLOW

Milestones	Date M - Y	Cash Flow (000's)
Prototype Trap Installed in Engine	10 - 86	20
Particle Accumulation Assessed in Engine Tests	12 - 86	40
Regeneration Control System Designed	3 - 87	50
System Installed in Buses	7 - 87	60
Bus Performance Evaluated	12 - 87	70
Report	3 - 88	80